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OPERATING EXPERIENCE WEEKLY SUMMARY

Office of Nuclear and Facility Safety

September 24 - September 30, 1999

Summary 99-39

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EVENTS

1. CONDUCT OF OPERATION DEFICIENCIES RESULT IN AUTHORIZATION BASIS VIOLATIONS

On September 21, 1999, at the Rocky Flats Environmental Technology Site Product Warehouse, DOE facility representatives identified several conduct of operations deficiencies that caused violations of the facility authorization basis. After reviewing the facility logs of a September 7 emergency diesel generator surveillance, they determined that the operational safety requirement to perform a 1-hour load test of the generator was not met. A shift manager had stopped the load test after approximately 15 minutes because the indicating range on the lube oil temperature gauge did not correspond to the operating temperature range for the diesel lube oil system. Investigators believe that facility personnel had installed a new gauge after performing the previous load test on August 6. They also discovered that during the August 6 surveillance, a radiator hose failed and no one (1) entered an out-of-tolerance condition, (2) terminated operations, or (3) performed an equipment return-to-service after they replaced the hose and generator coolant. DOE also determined that personnel did not perform a satisfactory surveillance of the emergency generator within the allowable grace period following the failed September 7 surveillance. DOE is investigating the adequacy of the associated backup battery surveillance. Rocky Mountain Remediation Services, who operates the facility, has voluntarily limited operations at the warehouse while they address the conduct of operations issues. NFS will continue to follow this event and will report the results in a future Weekly Summary. (ORPS Report RFO--KHLL-WSTMGTOPS-1999-0010)

KEYWORDS: conduct of operations, surveillance, emergency generator

FUNCTIONAL AREAS: Operations

2. OPERATOR INADVERTENTLY SHUTS OFF BREATHING AIR SUPPLY

On September 21, 1999, at the Savannah River Laboratory Technical Area, a breathing air manifold (halo) operator inadvertently shut off the air supply to a welding inspector's plastic suit. The loss of air forced the inspector to exit the work area to an air lock where his plastic suit was removed. Survey results of the inspector's protective clothing and nasal and saliva smears were negative. Inadvertent loss of breathing air can result in internal contamination or personnel injury by requiring the removal of respiratory protection equipment in hazardous atmospheres. (ORPS Report SR--WSRC-LTA-1999-0031)

A single halo supplied breathing air lines for the welding inspector and a maintenance mechanic. After leaving the work area, the mechanic began removing his plastic suit. A radiological control technician assisting the mechanic signaled to the halo operator to shut off the air supply to the mechanic. The halo operator inadvertently shut off the air supply to the welding inspector instead.

The facility manager held a critique of this occurrence. Attendees learned that the halo operator was trained and qualified in the use of plastic suits but had not received specific training for operating the halo. They also learned that the pre-job briefing had not addressed halo operation and communication protocols. Additionally, the fact that suits, hoses, and halo connections had not been systematically labeled as required by procedures contributed to the event.

OEAF engineers searched the ORPS database and found several occurrences involving the loss of breathing air. Two examples related to air-supplied hoods or plastic suits follow.

- An electrical and instrumentation mechanic at the Savannah River Site Laboratory Technical Area donned an air-supplied plastic hood that was not properly connected to a breathing air supply. The mechanic was removing his air-fed plastic suit at the step-off pad from an airborne radioactivity area. An operator and a radiological operations inspector were assisting in cutting the mechanic out of the plastic suit. Because the mechanic remained inside the airborne radioactivity area during the removal of his suit, he donned an air-supplied hood when the upper part of his suit was removed. The mechanic realized that air was not being supplied to the hood. The inspector immediately notified the breathing air standby watch person who checked the air supply pressure but could not find a problem. The inspector then discovered that the air-supply hose to the hood was only loosely connected to the air manifold. (ORPS Report SR--WSRC-LTA-1997-0012; Weekly Summary 97-14)

- A mechanic at the Savannah River Site H-Canyon Facility mistakenly cut into the breathing air hose for a separations operator who was inside an airborne radioactivity area. A second operator who was exiting the area had requested that the mechanic cut his air hose at the boundary as a means to minimize radioactive waste. The mechanic traced the wrong air hose and partially cut through the hose before air escaping from the line alerted him to the error. Investigators determined that the practice of cutting air hoses to minimize the generation of radioactive waste was not pre-approved and had not been discussed at the pre-job briefing. (ORPS Report SR--WSRC-HCAN-1997-0041)

These occurrences underscore the importance of formality in the operation of breathing air supplies. Removing plastic suits and transferring to air-supplied hoods requires a high level of coordination between workers, assistants, and breathing air manifold operators. To prevent similar occurrences, facilities that use plastic suits and air-supplied hoods should provide written instructions for the donning and removal of this equipment, including the coordination of breathing air supplies. Breathing air manifold operators or standby personnel should be formally trained in their responsibilities and in communication techniques specific to unique jobs during pre-job briefings. Work control packages and radiation work permits should clearly define breathing air requirements and procedures. Breathing air manifold connections, both ends of hoses, and plastic suit or hood connections should be labeled appropriately to aid in identification and communication. Numbered labels should be used where communication with breathing manifold operators is accomplished by hand signals.

KEYWORDS: breathing air, airborne radioactivity, respirator

FUNCTIONAL AREAS: industrial safety, radiation protection

3. CRANE BOOM STRIKES OVERPASS

On August 26, 1999, at the Nevada Test Site (NTS), the forward end of the boom on an 18-ton crane being transported on a low-boy trailer struck an overpass at approximately 40 miles per hour. The collision did not cause any injuries or seriously damage the overpass. However, it damaged sheaves at the boom head, broke a ½-inch wire rope, and snapped chains holding the rear of the crane to the trailer. NTS has decertified the crane and will hire a subcontractor to dismantle it and assess the damage. Site personnel expect the costs for inspection, repairs, and testing to exceed $10,000. This occurrence is significant because of its potential for injury and extensive property damage. (ORPS Report NVOO--BNLV-NTS-1999-0018)

The accident occurred approximately 300 yards from the NTS property line on the only access road to the NTS. A Site safety representative and the county sheriff's department conducted a preliminary investigation. The sheriff's department did not cite the driver because there were no signs at the overpass indicating overhead clearance. Investigators determined that the crane

boom was raised approximately two feet from the fully lowered position at the time of impact and that the boom head failed to clear the overpass by approximately two inches. The result was a scraping blow rather than a solid impact. Investigators have not yet determined who was responsible for verifying that the crane was properly configured for transportation.

As corrective actions, NTS managers are considering measuring the clearance at the overpass and posting a clearance notice at the NTS boundary, incorporating driver responsibility for checking load height into written instructions, and developing a lessons learned bulletin for NTS heavy equipment operators and drivers.

OEAF engineers reviewed two similar occurrences in the ORPS database.

- At the East Tennessee Technology Park K-25 Waste Management Facility, a drum crusher on the bed of a flatbed trailer snagged an overhead communications line. A restraining strap holding the drum crusher onto the trailer failed, and the load overturned. Investigation of this occurrence is incomplete. (ORPS Report ORO--BJC-K25WASTMAN-1999-0018)

- A transfer vehicle transporting a bucket truck from the Portsmouth Gaseous Diffusion Plant (PORTS) failed to clear a railroad underpass on a state road. The collision resulted in the total loss of the bucket truck. The PORTS Packaging and Transportation Department had notified an independent hauler that a low-boy trailer with a ground clearance of approximately 18 inches would be required to meet the State and Federal overall load height limit for general transportation of 13 feet, 6 inches. Instead, the hauler provided a step-up trailer with a ground clearance of approximately 36 inches. The driver accepted and departed with the load without qualifying the height of the load with the maximum general road usage requirements. (ORPS Report ORO--MMES-PORTBUSINS-1992-0001)

Additionally, in June 1999, a flatbed truck loaded with a large backhoe struck an unused concrete pedestrian bridge over a busy highway in Baltimore, Maryland. The collision collapsed the bridge onto rush-hour traffic, causing the death of the driver in a passenger car and injuries to three other people.

These occurrences underscore the significance of load verification when accepting a load for transport. Verification of load height is particularly important when load height may vary, such as when transporting equipment and materials on flatbed trailers or open-top haulage vehicles. OEAF engineers could not locate specific information in the U.S. Department of Transportation regulations regarding personal responsibility for verifying load heights. However, 49 CFR 392, *Driving of Commercial Motor Vehicles*, states in Chapter 9, “Safe Loading,” that drivers are responsible for ensuring loads are properly secured before starting a trip, after 25 miles into a trip, and periodically thereafter. It is reasonable to assume that the driver, as the person responsible for the load from its origin to destination, should also be responsible for verifying load height before starting a trip. All states require a special permit to transport over-dimension loads. Drivers should not accept loads without specifically checking overall load height against State and Federal limits for the routes being traveled. Also, drivers should not drive loads through overpasses or under overhead obstructions unless clearances are known. They should exercise special precautions on secondary roads, which may contain overpasses or obstructions that are not engineered to modern highway standards. Managers of DOE construction and transportation facilities should ensure that these principles are included in training and instructions for drivers.

KEYWORDS: accident, transportation, truck

FUNCTIONAL AREAS: Industrial Safety, Operations

4. IMPROPERLY STORED BATTERIES CAUSE FIRE

On September 27, 1999, at the Rocky Flats Environment Technology Site, a radiological control technician and a Salt Deputy Project Lead discovered a fire inside a toolbox, caused by an improperly stored battery that had short-circuited. They were performing a routine walk-down when they smelled smoke, and upon investigation, noticed that smoke was coming from a metal toolbox. They immediately summoned the fire department and then moved the toolbox away from a wall and surrounding combustible material. They lifted the toolbox lid and extinguished the fire using a dry chemical fire extinguisher. Fire department personnel arrived, secured the scene, and extinguished additional smoldering plastic battery casings. Fire department personnel determined that a battery terminal from a 12-volt gel cell battery short-circuited when it contacted the side of the toolbox, igniting combustible material inside the toolbox. Failure to properly handle and store batteries resulted in a fire that could have caused personnel injury or facility damage. (ORPS Report RFO--KHLL-PUFAB-1999-0070)

Investigators determined that electricians had removed approximately thirty 12-volt batteries from facility fire panels to replace them as part of a plant fire security replacement project. Because they were unable to return the batteries to a warehouse for recycling, the electricians temporarily stored them inside the toolbox. Although the electricians normally insulate battery terminals by putting tape on them to prevent the cells from short-circuiting during storage, the work package did not require them to tape the battery terminals nor did it include proper handling or storage steps. Investigators also determined that five of the batteries were damaged as a result of the fire and can not be recycled.

The facility manager held a fact-finding meeting and directed facility personnel to brief electrical personnel on this event. He also directed electrical personnel to verify the contents of similar toolboxes and directed facility personnel to further investigate this event to determine the history of the handling and storage of the batteries involved in this event.

NFS reported a similar event at Rocky Flats in which a battery short-circuited and caused a fire. On January 29, 1999, receipt inspection personnel were unpacking 12-volt, acid-filled batteries when at least one battery terminal short-circuited after contacting the metal casing of another battery, causing an arc and igniting packaging material. Investigators determined that when the receipt inspection personnel opened the package, they removed paper that had been placed between two of the batteries. Removal of the paper allowed contact between the positively charged battery terminal and the negatively charged metal casing of another battery, resulting in a maximum 24-volt electrical arc. They also determined that the vendor who shipped the batteries did not properly protect the battery terminals from short circuits. (ORPS Report RFO--KHLL-TRANSOPS-1999-0001)

These events illustrate the importance of being aware of hazards that could cause or contribute to a fire. These types of hazards should be identified by hazard analysis, and measures to minimize the hazards should be implemented. In the September event, the fire may have been much worse if it occurred during off-shift hours. In this scenario, the fire may have spread to the wall and surrounding area before anyone noticed it. The radiological control technician and the Salt Deputy Project Lead acted safely and quickly to extinguish the fire and prevent damage. This is an indication of a well-trained workforce. Positive means, such as taping battery terminals, are required to prevent them from short-circuiting.

Managers in charge of personnel who handle or store hazardous materials should review the following and ensure that procedures reflect the safety requirements for storage and that employees are trained on these procedures and understand them. Work planners should ensure that work packages adequately address actual and potential workplace hazards.

- DOE O 5480.23, *Nuclear Safety Analysis Reports*, requires hazard analysis to ensure comprehensive, integrated, and balanced risk management of all safety and environmental hazards. Section 3 requires analyses of expected releases,

exposures, and accidents. It also requires consideration of residual risks to ensure that the risks and consequences of operation are acceptable and to ensure conformance with safety design objectives.

- DOE-STD-1071-94, *Guideline to Good Practices for Material Receipt, Inspection, Handling, Storage, Retrieval, and Issuance at DOE Nuclear Facilities*, provides guidance for establishing proper storage and control of hazardous materials.

- DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, provides guidance for protecting workers from hazardous materials.

- DOE/ID-10600, *Electrical Safety Guidelines*, section 6.5 states "accidental shorting of the exposed terminals or cables of a battery can result in severe electric arcing, causing burns and electrical shock to nearby personnel." It also states that batteries of any size should be considered an electrical hazard.

DOE standards can be found at http://tis.eh.doe.gov/techstds/standard/standfrm.html.

KEYWORDS: hazardous material, battery, fire

FUNCTIONAL AREAS: Fire Protection, Materials Handling/Storage

5. BREATHING ZONE AIR SAMPLES EXCEED PERMISSIBLE EXPOSURE LIMIT FOR CADMIUM

On September 14, 1999, at the Los Alamos National Laboratory, the facility manager of the Health Research Laboratory reported that breathing zone air samples taken from two ironworkers indicated the presence of cadmium in excess of the OSHA Permissible Exposure Limit (PEL) of 0.005 milligrams per cubic meter (mg/m^3) of air over 8 hours. The ironworkers were cutting Unistrut with an oxygen/acetylene torch as part of a metal-cutting project. They were not wearing respiratory protection at the time. Both ironworkers were referred to the Occupational Medicine Group for urine and blood analyses. As part of the job preparation, industrial hygienists had tested for the presence of lead but did not test for cadmium. Events involving acute or chronic exposures to airborne cadmium can cause serious health problems. (ORPS Report ALO-LA-LANL-HRL-1999-0003)

On September 2, 1999, an ironworker crew began disassembling and cutting a metal catwalk and a series of animal cage structures. After approximately 25 minutes of cutting into the Unistrut and surrounding metal structures, the ironworkers noticed an unexpected odor. They stopped cutting and consulted with an on-site Johnson Controls Northern New Mexico (JCNNM) industrial hygienist who was supporting the work crew. The industrial hygienist advised them to discontinue cutting operations until further evaluation. On September 13, JCNNM industrial hygienists received breathing zone air samples taken from both ironworkers. The sample from the first ironworker read 0.12 mg/m^3 over 34 minutes or 0.0085 mg/m^3 over 8 hours. The sample from the second ironworker read 0.21 mg/m^3 over 35 minutes or 0.015 mg/m^3 over 8 hours. The facility manager deferred all cutting operations until further direct reading data and medical evaluation results are obtained.

Investigators learned that a week before starting the project, a JCNNM industrial hygienist had used a hand-held NITON® x-ray fluorescence, direct-reading instrument to identify and locate the presence of lead that may be present during the cutting operation. The instrument identified the presence of zinc, magnesium, and possibly manganese. In addition, lead was identified in metal structures in one specific portion of the project. Based on the identified metals, and the additional task and site hazards, safety personnel assembled a complete work package for

cutting the galvanized metal. The ironworkers were instructed to work first on the metal structures that did not contain lead. Identified controls for this portion of the project included the use of protective eyewear, gloves, and a portable exhaust unit. Industrial hygienists took breathing zone air samples from the two ironworkers while they were cutting to verify the accuracy of the instrument and to measure the efficiency and adequacy of the portable exhaust unit. The breathing zone air samples were then sent to an off-site laboratory for a full metals-suite analysis.

On September 14, the facility manager held a critique of the event. Critique members learned that although the hazard identification process identified the presence of lead, it failed to identify the presence of cadmium. Consequently, appropriate personal protective equipment and other controls were implemented for the identified lead hazard, but not for cadmium, the more toxic material. Also, industrial hygienists did not exchange the source present in the NITON® x-ray fluorescence instrument that would have allowed the instrument to detect the presence of cadmium. Finally, they learned that Unistrut, and perhaps many other metal parts, like bolts, which exist throughout the Laboratory, may contain cadmium.

NFS has reported several exposures to cadmium in the Weekly Summary. Some examples follow.

- Weekly Summary 98-51 reported two occurrences at the Sandia National Laboratory involving elevated exposures of employees to hazardous metals. Two employees in Area 10000 received exposures to cadmium and lead fumes or dust that exceeded OSHA PELs. The cadmium exposure was 4.5 times the PEL and the lead exposure was 1.5 times the PEL based on analysis of breathing zone air samples. The employees were using a torch to cut metal that had been excavated from a waste landfill. A radiation protection technician in Area 6000 was exposed to cadmium dust at twice the PEL. The technician had been surveying materials removed from a waste landfill and sweeping dust from shelves in the area. (ORPS Reports ALO-KO-SNL-10000-1998-0006 and ALO-KO-SNL-6000-1998-0006)

- Weekly Summary 98-42 reported that two workers at the Idaho Waste Experimental Reduction Facility were exposed to airborne cadmium dust at levels that exceeded the protection factor for the respiratory protection equipment that they were wearing. The individual workers could have been exposed to as much as 1.16 and 2.68 times the PELs for cadmium dust of 0.005 mg/m^3. The workers were cleaning and inspecting an incinerator off-gas heat exchanger in which cadmium had previously been injected. Although facility operators had encountered cadmium dust above the PEL in the heat exchanger during past cleanings, engineers did not expect the same very high levels encountered during this task. Facility personnel revised the Lead and Cadmium Compliance Plan to require a respirator with a higher protection factor and to develop more effective engineering and administrative controls to mitigate cadmium hazards. (ORPS Report ID--LITC-WERF-1998-0007)

These events underscore the importance of performing a thorough activity hazard analysis. It is often difficult or impossible to measure concentrations of airborne contaminants in real time. Analysis of breathing zone air samples may require up to several days to complete. Atmospheric or surface samples taken before work begins are generally unreliable indicators of the contamination that may be introduced as work progresses. Uncertainties regarding contamination levels that may be encountered during work should dictate highly conservative approaches to work planning and selecting and using respiratory protection equipment. Acute exposure to cadmium can cause pulmonary edema or death, and chronic exposures can cause kidney damage and lung or prostate cancer. Industrial hygienists, safety personnel, and work planners should review the following guidance.

- DOE 440.1A*, Worker Protection Management for DOE Federal and Contractor Employees*, requires all DOE elements to assess worker exposure to chemical, physical, biological, or ergonomic hazards through appropriate workplace monitoring (including personal, area, wipe, and bulk sampling), biological monitoring, and observation.

- 29 CFR 1910.1000, *Airborne Contaminants*, states that whenever feasible, compliance with exposure limits for airborne contaminants must be achieved by determining and implementing administrative or engineering controls. If administrative or engineering controls are not feasible to achieve full compliance, protective equipment or other protective measures must be used to keep the exposure of employees to air contaminants within prescribed limits.

- 29 CFR 1910.134, *Respiratory Protection*, states that when employers cannot identify or reasonably estimate employee exposure, they must consider the atmosphere immediately dangerous to life and health, which requires use of a full-face, pressure-demand, self-contained breathing apparatus or supplied-air respirator with an auxiliary self-contained air supply.

- If exposure to cadmium is expected, work planners should also review 29 CFR 1910.1027, *Cadmium*, for information on developing work plans and monitoring programs. The standard states that if initial monitoring reveals employee exposures at or above the PEL, the employer must monitor at a required frequency and pattern to assure the adequacy of respiratory selection and the effectiveness of engineering and work controls. Also, 29 CFR 1910.1027 appendix A, "Substance Safety Data Sheet - Cadmium," provides health hazard data, emergency first aid procedures, and protective clothing and equipment information. If the work is considered construction, which involves potential exposure to cadmium when performing alterations, repairs, or cadmium welding or cutting, then work planners should review 29 CFR 1926.1127, *Cadmium*. OSHA standards are available at http://www.osha-slc.gov/OshStd_toc/OSHA_Std_toc.html.

KEYWORDS: exposure, hazard analysis, industrial hygiene, permissible exposure limit, respirator, work planning

FUNCTIONAL AREAS: Industrial Safety, Work Planning

6. OPERATOR FALSIFIES READINGS ON A FACILITY ROUND SHEET

On September 23, 1999, at the Pacific Northwest National Laboratory, an operations supervisor discovered that a night shift power operator had falsified entries on round sheets. The operator entered readings on the round sheet for instrument air pressure and water level for a tank that contained a cobalt-60 source despite being unable to enter the facility to obtain the readings. The operations supervisor discovered the falsified entries when the oncoming shift operator reported to the supervisor that she was unable to enter the facility to obtain the readings because an asbestos abatement boundary prevented her from doing so. Falsifying equipment data or status can compromise facility safety. (ORPS Report RL--PNNL-PNNLBOPER-1999-0029)

Investigators determined that the operator entered false readings on round sheets on two separate tours during the night shift. They also determined that asbestos abatement workers had erected the boundary after the previous shift readings had been obtained by another operator. Asbestos work planners did not notify the organization responsible for coordinating power operator rounds. After the operations supervisor discovered the falsified entries, the operator resource manager performed a facility walk-through to obtain correct readings. He also

discussed tour operating procedures with the night shift operator. These procedures require the operator to report to his supervisor when it is not possible to obtain readings. Tank water level monitoring is important because the water provides personnel radiation shielding from fields associated with the cobalt-60 source.

NFS has reported on falsification of records and documentation in previous Weekly Summaries. Weekly Summary 93-10 reported that a shift technical advisor at Rocky Flats found that a fire watch was not performing his required duties. His main safety function was to observe site areas that had no functional automatic fire detection system. The shift technical advisor found the fire watch reading a magazine during his shift. He had filled out the fire watch log sheet, documenting completion of his fire watch inspection, 20 minutes before it was scheduled. (ORPS Report RFO--EGGR-PUFAB-1993-0047).

OEAF engineers reviewed the ORPS database and found another event involving falsification of records. On September 15, 1999, at the Mound Plant, facility managers learned that a radiological control technician (RCT) falsified a radiological survey record by entering survey result data for a survey he had never performed. The RCT admitted that a fabrication mechanic had skin contamination, and that he did not tell the mechanic that he was contaminated. As a result, facility managers were unaware of the potential to become contaminated, and a second worker became contaminated several days later while working in the same area. (ORPS Report OH-MB-BWO-BWO01-1999-0018)

These events underscore the importance of following procedures. Workers must assume responsibility for their work, pay attention to detail, and adhere to procedures and instructions. When conditions prevent the performance of any procedure, work must be stopped immediately, and the conditions must be reported to supervisors. DOE 5480.19, *Conduct Of Operations Requirements For DOE Facilities*, chapter I, "Operations Organization and Administration," discusses high levels of accomplishment in DOE operations by holding workers and their supervisors accountable for their performance. Falsifying records is unacceptable, and the falsification of equipment data or status may compromise plant safety. Technical reviews based on corrupt data may lead personnel to believe that the facility is operating safely, thus precluding appropriate actions to rectify adverse conditions.

Facility managers should review DOE/NS-0009, Safety Notice No. 92-4*, Facility Logs and Records*. The Notice summarizes situations at DOE facilities where logs were falsified, incorrectly entered, or not completed. These practices are inconsistent with DOE requirements and guidelines. Safety Notice 92-4 can be obtained by contacting the ES&H Information Center, (800) 473-4375, or by writing to U.S. Department of Energy, ES&H Information Center, EH-72, 19901 Germantown Road., Germantown, MD 20874. Safety notices are also available at http://tis.eh.doe.gov:80/web/oeaf/lessons_learned/ons/ons.html.

KEYWORDS: procedure, violation

FUNCTIONAL AREAS: Procedures, Operations

7. CONTRACTOR SPRAYED WITH HAZARDOUS CHEMICAL

On September 21, 1999, at the Lawrence Livermore National Laboratory, a hazardous waste management contractor was sprayed with a slurry of Raney nickel when the cap on a hazardous waste container blew off. Approximately 2.5 ounces of the slurry was released, spraying the contractor and the ceiling. He was preparing waste containers for shipment to an off-site waste disposal facility, and violated procedures by adding water to the container. The water reacted with the Raney nickel releasing hydrogen and pressurizing the container. Raney nickel is a finely-divided alloy of nickel and aluminum, suspended in water. This event is significant because improper handling of hazardous chemicals can cause serious personnel injury. (ORPS Report OAK--LLNL-LLNL-1999-0045)

In the dry, powder form, Raney nickel is highly flammable. The contractor added demineralized water to the container of Raney nickel because he believed that additional water was necessary to completely saturate the Raney nickel. Investigators determined that the procedure used by the contractor did not allow him to modify the contents of any container. The procedure required the contractor to stop work and request a safety analysis before adding water. Investigators believe that when the contractor added water to the Raney nickel, hydrogen gas was generated. Because he immediately capped the container tightly after adding the water, the container overpressurized causing the cap to blow off. The contractor was wearing safety glasses, gloves, protective clothing, and hard-toed shoes. Facility personnel assisted the contractor with washing the Raney nickel off of his hair and the collar of his protective clothing. Medical personnel evaluated his condition and immediately released him to return to work.

NFS has reported other events in the Weekly Summary involving unexpected chemical reactions. Some examples follow.

- Weekly Summary 98-18 reported that an employee at the Lawrence Livermore National Laboratory received chemical burns to his face when a plastic bottle pressurized, ruptured, and sprayed its contents. Investigators determined that the bottle contained sulfuric acid, nitric acid, and acidified hydrocarbon oil. In this event, laboratory workers mixed incompatible materials, which resulted in a lost-time injury. (ORPS Report SAN- -LLNL-LLNL-1998-0025)

- Weekly Summary 97-29 reported a building evacuation at the Lawrence Livermore National Laboratory because of fumes generated by mixing a solution of nitric acid, hydrogen fluoride, and acetic acid with a solution of ethanol, hydrofluoric acid, and water. Investigators determined that the fumes resulted from a chemical reaction between incompatible materials being mixed for waste disposal by a technician. (ORPS Report SAN--LLNL-LLNL-1997-0037)

- Weekly Summary 96-40 reported that a researcher at the Oak Ridge Environmental Sciences Center was adding methanol to two vials containing sodium permanganate and polychlorinated biphenyls when an unexpected energetic reaction caused the mixture to spray from the vials. Approximately 1 ml of the mixture sprayed onto the researcher's gloves. Investigators determined that an inadequate evaluation of chemical compatibility allowed the reaction to occur. (ORPS Report ORO--ORNL-X10ENVIOSC-1996-0001)

These events highlight the importance of chemical workers properly assessing the risks involved when working with hazardous chemicals. In facilities where hazardous chemicals are handled, workers should stop work whenever the specific hazards of handling, mixing, and storing these chemicals has not been fully assessed. Facility managers should emphasize the importance of researching all available sources of chemical safety information, particularly when performing first-time or infrequent operations. Information about chemicals, chemical hazards, and chemical safety programs are located on the DOE Office of Environment, Safety and Health, Office of Worker Safety, Chemical Safety Program home page. The home page is located at http://tis-hq.eh.doe.gov/web/chem_safety/. It provides links to many sources of information, including requirements and guidelines, lessons learned, chemical safety networking, and chemical safety tools.

The following DOE and industry documents provide valuable guidance for all personnel who work with chemicals and hazardous materials.

- DOE-HDBK-1100-96, *Chemical Process Hazards Analysis,* and DOE-HDBK-1101-96, *Process Safety Management for Highly Hazardous Chemicals,* provides guidance for DOE contractors managing facilities and processes covered by 29 CFR 1910.119, *Process Safety Management of Highly Hazardous Chemicals.*

Both handbooks are available on the DOE Technical Standards home page at http://tis.eh.doe.gov/techstds/standard/ standfrm.html.

- DOE Defense Programs Safety Information Letter, SIL 96-01, *Incidents from Chemical Reactions Due to Lack of or Failure to Follow Proper Handling Procedures,* provides guidance on preventing accidental chemical reactions as a result of improper chemical storage, handling, shipping, and mixing. Safety Information Letter 96-01 is available at http://www.dp.doe.gov/Public/ default.htm.

- 29 CFR 1910.1450, *Occupational Exposure to Hazardous Chemicals in Laboratories*, provides direction on the use of chemicals. It covers signs and labels, spills and accidents, basic rules and procedures, and training and information. 29 CFR 1910.1450 is available on the OSHA home page at http://www.osha-slc.gov/OshStd_data.

KEYWORDS: chemical reaction, hazardous material, occupational safety, procedures

FUNCTIONAL AREAS: Industrial Safety, Materials Handling/Storage

8. MISUNDERSTANDING OF ELECTRICAL SYSTEM CAUSES LOSS OF POWER

On September 20, 1999, at the Los Alamos National Laboratory, an electrical crew inadvertently caused a loss of electrical power to Wing 4 of the Chemistry and Metallurgy Research Facility while conducting a 5-year preventive maintenance on high-voltage transformers and switches. The electricians removed the wrong electrical disconnect because they did not fully understand the configuration of the electrical lineup. The procedure was not accurate as to which disconnect to remove, and one disconnect was incorrectly labeled. The loss of electrical power caused a loss of process ventilation, termination of normal operations, and the automatic switch over of the fire alarm system to battery backup power. Personnel evacuated the wing in accordance with facility procedures to prevent possible radiation exposure. Although there was no loss of containment of radioactive material, ventilation system upsets can cause the spread of contamination. (ORPS Report ALO-LA-LANL-CMR-1999-0029)

Wing 4 has two substations (W4T and W4C) that are fed through a 13.2-kV, automatic transfer switch, which can transfer between an east and west primary feeder that contains a sectionalizing switch. Each substation has two transfer switches that have in-line electrical disconnects (or elbows) for isolation. The transfer switches allow each substation to alternately receive power from either the east or the west primary feed.

A Johnson Controls Northern New Mexico electrical crew was de-energizing both electrical feeds to the transformer and switches in substation W4T in accordance with a maintenance procedure. The procedure required de-energizing the electrical feeds one at a time and removing the elbows. The procedure identified the elbows for removal by referring to the circuit from which they were fed. Each elbow had a tag that identified its feed circuit. The electrical crew disconnected the main feed line to the substations by opening the west sectionalizing switch and then removed one of the elbows in W4T, as specified in the procedure. Power was being maintained to the substations through a secondary electrical feed. The crew then reconnected the main feed line by closing the sectionalizing switch. At this time, power to the substations was supposed to be maintained from the main feed line through the other transfer switch in W4T that provided power to W4C. To isolate the equipment requiring service, the crew opened the circuit breaker for the secondary feed to substation W4T. However, when the breaker was opened, power was lost to both substations and all electrical power to Wing 4 was lost.

The facility manager terminated normal operations in the wing, as required by the limiting conditions for operation in the interim technical safety requirements. Because the ventilation system was inoperable, health physics personnel conducted surveys of the radiological buffer areas and confirmed that there was no loss of containment.

Investigators determined that one of the in-line elbows in W4C was improperly labeled. The removed elbow was the one that was to provide power to W4C while W4T was de-energized. This resulted in disconnecting the main feed line to the substations and the loss of all power to the substations. Investigators learned that the circuitry had been installed in 1989 and none of the elbows were labeled at that time. When the 5-year preventive maintenance was performed in 1994, personnel traced the circuits and labeled some of the elbows. However, they incorrectly labeled an elbow for the in-line disconnect in substation W4C, which caused personnel involved to remove the wrong elbow. Because of this finding, investigators determined that the direct cause of the event was personnel error (inattention to detail).

Investigators determined that there were two contributing causes. The first cause was also inattention to detail because the electrician assigned to remove the elbows to the switches and the foreman who supervised the work did not recognize that the labeling on one of the in-line elbows was incorrect. The configuration with only two cables could not be used to disconnect two different circuits and could only be used as an in-line disconnect for a single circuit. The system was also difficult to understand and was not completely understood until the investigation was completed. The second contributing cause was a management problem (work organization/planning deficiency) because the preparation of procedures was done with electrical schematics that showed only the major equipment and switches. The locations of the elbows, especially the in-line elbows, were not shown, making it difficult to understand the system logic.

Investigators determined that the root cause of the event was a management problem (inadequate administrative control) because the configuration logic, with in-line disconnects in the substations, was not understood by the personnel who developed the procedure or who performed the work. The personnel did not understand that there were alternate points where switches could be disconnected. The locations where the elbow opening and closing steps were to be performed were not identified, and this eventually resulted in the wrong elbow being removed because of incorrect labeling of one of the elbows.

As a corrective action, the facility manager will require that all elbows be traced out and walked-down to ensure that they are labeled correctly. There is an effort underway at CMR to get accurate as-built drawings. Pre-planning, pre-job meetings, and job walk-downs should help to identify these types of problems. Personnel who are trained to ask questions when things do not look or feel right are also important in identifying problems.

This event underscores the importance of ensuring that information on the exact configuration of systems or components is reflected in the as-built documentation. Physical inspections should be performed to verify that documentation, including procedures, depicts the actual physical configuration and is consistent with the design requirements. DOE-STD-1073-93–Pt.1 and –Pt.2*, Guide for Operational Configuration Management Programs, Including the Adjunct Programs of Design Reconstitution and Material Condition and Aging Management*, provides guidelines and good practices for an operational configuration management program including change control and document control. The standard also provides program criteria and implementation guidance for establishing and maintaining consistency among design requirements, physical configuration, and facility documentation. An effective configuration management program will increase the availability and retrievability of accurate information to support safe, sound, and timely decision-making related to facility design and operations.

KEYWORDS: configuration control, electrical outage, preventive maintenance, procedures, training and qualifications

FUNCTIONAL AREAS: Configuration Control, Procedures, Electrical Maintenance

FINAL REPORTS

This section of the OEWS discusses events filed as final reports in the ORPS. These events contain new or additional lessons learned that may be of interest to personnel within the DOE complex.

1. OPERATOR EXPOSED TO SULFUR DIOXIDE GAS

On August 3, 1999, at the Weldon Spring Site Remedial Action Project, a subcontractor operator was exposed to sulfur dioxide gas while transferring a 38-percent solution of sodium bisulfite from a 55-gallon drum to a 50-gallon process tank for a reverse osmosis unit. The operator was manually pumping the solution through Tygon® tubing into a 2-inch opening with a hinged lid at the top of the tank. The opening was not sealed to prevent the release of gases. Sulfur dioxide gas, a natural by-product generated when sodium bisulfite is mixed with water, was released from the opening during the transfer process. The gas is an inhalation hazard and can irritate throat and mucous membranes. It can also damage the upper respiratory tract and lung tissues. After his exposure, the operator experienced coughing and tightness in his chest. Site personnel took the operator to a hospital for treatment and evaluation where the attending physician diagnosed him as having chemically-induced pneumonia. This event is significant because a hazard analysis performed for this operation did not completely consider chemical by-products and potential release paths during the pumping process, which allowed the operator to be exposed to a toxic gas. (ORPS Report ORO--MK-WSSRAP-1999-0017)

Investigators determined that previous transfers of sodium bisulfite had been conducted by pumping the solution into a container and then pouring the container contents into the tank. However, due to the high ambient temperature and the requirement for the operators to wear full-face respirators while using this method, water-treatment personnel selected the alternative method of manually pumping the solution from the drum directly into the tank. The engineer who performed the hazard analysis for the alternative method determined that the pump, tubing, and tank were a closed system and that respiratory protection and airborne exposure monitoring were not required.

Investigators determined that the direct cause of this event was Design Problem: Inadequate Work Environment because the hazard analysis erroneously identified the alternative transfer method as a closed system with respect to vapors, gases, and air emissions. Adequate personal protective equipment (PPE) and airborne exposure monitoring were not provided. The pump, tubing, and tank transfer system was not designed to preclude the need for respiratory protection. Investigators have not determined whether the worker's exposure was due to emissions released from the tank opening, vapors emitted from the seal on the transfer pump, or both.

Investigators determined two contributing causes for this event. The first contributing cause was Equipment Material Problem: Defective or Failed Parts. The pump used during the transfer leaked sodium bisulfite solution from along its handle onto the drum. The second contributing cause was Personnel Error: Inattention to Detail. The Environment, Safety, and Health (ES&H) representative responsible for determining the appropriate PPE and airborne monitoring for this process did not consider the potential for gases to emerge from the unsealed 2-inch opening at the top of the tank. The material safety data sheet for sodium bisulfite recommends the use of a respirator when handling this substance due to the potential for the release of sulfur dioxide gas. Investigators also determined an additional personnel error occurred because the operator continued to pump the solution after he noticed the solution leaking from the pump.

Investigators determined that the root cause of this event was Personnel Error: Procedure Not Used or Used Incorrectly. The ES&H representative performed an inadequate hazard analysis in accordance with the industrial hygiene monitoring plan for the facility. He incorrectly determined that the alternative transfer method was a closed system, and he did not conduct an adequate exposure assessment for the release of sulfur dioxide while the worker transferred the sodium

bisulfite solution. The hazard analysis should have specified performing airborne-exposure measurements during the transfer, or the worker should have been required to wear a respirator. Site personnel have substituted an electric pump for the manually operated pump to transfer the solution from the drum to the tank, and personnel are barricaded from the area while the pump is operating. This design has eliminated the need for respiratory protection equipment during transfer operations.

This event demonstrates the importance of performing a complete and accurate hazard analysis that considers the entire system including (1) the chemical hazards involved, (2) by-products of the chemicals being handled, and (3) potential pathways for release of the chemicals or their by-products.

KEYWORDS: airborne monitoring, chemical, inhalation, industrial safety, injury, job-hazard analysis, personal protective equipment

FUNCTIONAL AREAS: Industrial Safety

OEAF FOLLOWUP ACTIVITY

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